OSLO: Open Standards for Linked Organizations

Raf Buyle, Laurens De Vocht, Mathias Van Compernolle, Dieter De Paepe, Ruben Verborgh, Ziggy Vanlishout, Bjorn De Vidts, Peter Mechant, and Erik Mannens

In: Proceedings of the International Conference on Electronic Governance and Open Society: Challenges in Eurasia, 126–134, 2016.

http://doi.acm.org/10.1145/3014087.3014096

OSLO: Open Standards for Linked Organizations

Raf Buyle[1], Laurens De Vocht[1], Mathias Van Compernolle[2], Dieter De Paepe[1], Ruben Verborgh[1], Ziggy Vanlishout[3], Björn De Vidts[3], Peter Mechant[2] and Erik Mannens[1]

[1] {firstname.lastname}@ugent.be
[2] {firstname.lastname}@ugent.be
[3] {firstname.lastname}@kb.vlaanderen.be

[1] Data Science Lab
iMinds - Ghent University
Ghent, Belgium

[2] MICT
iMinds - Ghent University
Ghent, Belgium

[3] Informatie Vlaanderen
Flemish Government
Brussels, Belgium

ABSTRACT

Each government level uses its own different information system. At the same time citizens expect that these governmental levels adopt a user-centric approach and provide instant access to their data or to open government data. Therefore the applications at various government levels need to be interoperable in support of the 'once only-principle': data is inputted and registered only once and then reused. Given government budget constraints and the cost and complexity of (re)modeling, translating and transforming data over and over, public administrations need to reduce interoperability costs. This is achieved by semantically aligning information between the different information systems of each government level. Semantical interoperable systems facilitate citizen-centered e-government services. This paper illustrates how the Open Standards for Linked Organizations program (OSLO) paved the way bottom-up from a broad basis of stakeholders towards a government-endorsed strategy. OSLO applied a generic process and methodology and provided practical insights on how to overcome the encountered hurdles: political support and adoption; reaching semantic agreement. The lessons learned in the region of Flanders (Belgium) can speed-up the process in other countries that face the complexity of integrating information intensive processes between different applications, administrations and government levels.

CCS Concepts

• **General and reference~Computing standards, RFCs and guidelines** • *Applied computing~Enterprise data management* • *Applied computing~E-government*

Keywords

Public Administration; Interoperability; e-Government; RDF; Vocabulary; Domain Model

EGOSE '16, November 22 - 23, 2016, St.Petersburg, Russian Federation
Copyright is held by the owner/author(s). Publication rights licensed to ACM.
ACM 978-1-4503-4859-1/16/11...$15.00

DOI: http://dx.doi.org/10.1145/3014087.3014096

1. INTRODUCTION

One of the most widespread e-government best practices is the 'once-only principle[1]' which states that citizens and businesses have to provide administrative information only once to a public administration, avoiding administrative burden. To achieve this, administrations must be able to share and reuse this information across different applications and processes.

A good example are Local governments in Flanders, which provide over 800[2] different products and services. To support their processes and service delivery, they use back-office applications from different software vendors. These domain specific applications are organized as vertical processes, requesting administrative data from citizens and business which often cannot be reused by other applications, causing data silo's.

The Open Standards for Linked Organizations program (OSLO) transformed IT-service delivery efforts in the Region of Flanders (Belgium) in fundamental ways. Its strategy focuses on semantic agreements and machine readable data which softens the existing data silo's on various governmental levels and facilitates the once only principle.

This paper reports on the development, methodology and the outcome of the Open Standards for Linked Organizations program.

OSLO started in February 2012 and the first phase has ended in 2015. The project was the result of a public-private partnership initiated bottom-up by the Flemish Organization for ICT in Local Government (V-ICT-OR), and co-funded by Flemish ICT service providers and Flemish Government Administrations. The project was also supported by a wider community, including Local, Regional and Federal administrations, non-profit organizations, academic partners and the European Commission program Interoperability Solutions for European Public Administrations (ISA).

In Flanders there are various governmental levels with their own jurisdiction, presented simplified in Figure 1. Each level has various data sources and applications:

- The *authoritative* (official, established) sources about people and enterprises are the federal (national) sources in Belgium (I).

[1] https://joinup.ec.europa.eu/community/once-only-principle/home

[2] http://productencatalogus.vlaanderen.be/fiches

- The *authentic* sources (embedded in policies, obliged and supported by the regional government (II) with address information and geographical locations are a regional responsibility.
- At the local level, 308 municipalities provide a variety services to enable public service delivery for citizens and business (III). Local governments consume the authentic data from the Federal and Regional government and are often responsible for the creation and maintenance of authoritative data at the other administrative levels (I, II). A lack of interoperable information products at local level, has led to redundant and repeated data.

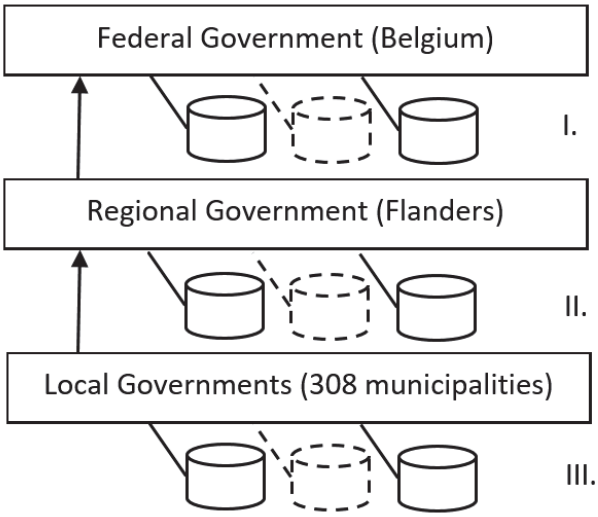

Figure 1 Simplified view of the various governmental levels in Flanders, Belgium.

OSLO focusses on a broader framework, in line with the European Interoperability Framework. At the start of the program the governance was at the level of membership organizations (ICT, secretary, financial managers) of local governments, regional and federal administrations, referred to as the steering committee.

The program focused on semantic interoperability. Semantic interoperability "enables organizations to process information from external sources in a meaningful manner. It ensures that the precise meaning of exchanged information is understood and preserved throughout exchanges between parties"[3]. The project had two main tracks: (i) gain 'political support and adoption' and (ii) develop the 'semantic agreement'. Political support is essential, for collecting sponsoring and gaining authority and engagement. Semantic agreement is expressed in a domain model.

Semantic interoperability facilitates information exchange without a specific translation step. Two organizations are semantically interoperable if they know how to interpret data from each other and can reuse each other's data directly. Public administrations should support and monitor these information management processes which should lead to better interoperability. For example, providing direct feedback such as an interoperability score when a new dataset has been published can help the adoption of the available vocabularies [3].

OSLO provides three variants of its domain model:

- a human readable specification, covering the domain model itself, examples and a conformance statement;
- a technical implementation serialized to XML;
- an implementation following the Resource Description Framework (RDF).

1.1 Overview

This paper provides an in-depth insight into the process and methodology of developing better public services in Flanders. We expect that this process and methodology can be applied by other administrations in order to facilitate their Open Government Data policy and to support the development of Citizen Centered E-Government services.

We explain the importance of interoperability in section 1 and motivate why it is crucial to focus on different interoperability levels. More specific, we will explain how both 'Political support and adoption' and 'Semantic Agreements' are cornerstones for ensuring interoperability. Section 2 describes the research goal and the applied method, followed by a description of how OSLO created the conditions to reach 'Political support and adoption' in section 3. Here we also discuss the process to reach 'Semantic Agreement' and the domain model, which is the starting point for the implementation. Section 4 illustrates the different characteristics of OSLO. After a short discussion in section 5, this paper ends with sect. 6 where we present the conclusions.

1.2 Background

Public data often has a location-related component: "(…) It is estimated that 80% of the informational needs of local government policymakers are related to geographic location." [7].

In many cases the location is the anchor to which other information or data is linked to, for example: construction permits for residential houses; or environmental permits for industrial areas. Despite the existence of these sources (Figure 1), the non-availability of interoperable information products related to public services led to local governments and their software suppliers being unable to connect to these data sources. The processes that drive these products are often digitalized in separate systems. Due to this, *shadow* databases arise which lead to lots of redundant and repeated data. The quality of this information, ultimately delivered through e-government or other public services to citizens, is not as good as the authoritative data sources and certainly not as guaranteed or supported. This leads to a fragmented view of the public service concept which impacts the quality and the efficiency of public services. This fragmented view is a major obstacle for the development of citizen and businesses centered services because data sources were developed as independent products, each modeling information differently. This causes unnecessary translation steps which triggers multiple investments for interlinking data. Citizens benefit from once-only information delivery approaches; public administrations should not request information from citizens and businesses that already has been provided in another context, increasing government effectiveness and efficiency, and decreasing administrative burden [6][14].

In Europe, various frameworks have emerged to safeguard interoperability in the deployment of e-government services, both at national and at European level [8]. Methodologies for linking

[3] http://ec.europa.eu/isa/documents/isa_annex_ii_eif_en.pdf , p28

government data as such are not new: many guidelines considering applications, methodology, coverage and quality exist [19]. In particular the Interoperability Solutions for Public Administrations (ISA) Programme, now in its second chapter, promotes semantic interoperability among the European Union Member States[4].

1.3 Goals of the program

OSLO is an interoperability facilitator. Data cannot pass by default through different applications, because each application models the 'real world' from a (slightly) different, therefore OSLO:

- transforms the delivery of public and government services so that citizens and businesses have to provide their information only once, an it is shared across the different applications and informations systems,
- aggregates information from different national, regional and local e-government information systems or combines existing services to create new ones;
- creates machine-readable public service descriptions that are reusable (following the Linked Open Government Data paradigm) and enable functionalities such as automated service discovery and composition[5].

With an inventory[6] of problems related to the exchange of information for local authorities in Flanders, the local governments 'promoters' of OSLO created the necessary support at the local level, and crowd funded the initiative. Among the initial sponsors were Flemish ICT service providers; major cities and a Regional Government Administration.

In a parallel process, the promoters created a coalition of willing administrations at various government levels, by explaining the impact of those interoperability problems on citizens, businesses and administrations. Next, collaboration with the ISA Program was realized[7] in order to create more stable standards (because the governance is at the EU level) and to create a more authoritative setting.

According to the European Commission Directory General for Communications Networks, Content and Technology (DG CONNECT)[8] boundaries between public and private services will fade. The increased connectivity of citizens and businesses, the possibility for people to work together, perform tasks and distribute workload regardless of distance and boundaries as well as the availability of previously closed information and data, implies that government tasks can also be performed - completely or in part - by citizens or companies. Potential near-future applications could involve the reuse of own data to have contact data delivered to the energy supplier, behind the scenes, without having to fill in yet another form; or to validate if one has the required vaccines before traveling.

[4] http://ec.europa.eu/isa/actions/01-trusted-information-exchange/1-1action_en.htm

[5] https://joinup.ec.europa.eu/asset/core_public_service/description

[6] http://contactinformatie.v-ict-or.be/documentation/OSLO_discussienota_inventarisatiefase%201_0.pdf

7 Flemish OSLO standard to become a local extension of the ISA core vocabularies: https://joinup.ec.europa.eu/community/semic/news/flemish-oslo-standard-become-local-extension-isa-core-vocabularies

[8] https://ec.europa.eu/digital-single-market/en/dg-connect

The ISA Programme promotes interoperability across multiple interoperability levels between Member State's borders and public service sectors, see Figure 2. One of its key components is the European Interoperability Framework (EIF)[9]. EIF is a set of recommendations which specify how administrations, businesses and citizens communicate with each other within the EU and across borders. These interoperability levels are defined as legal, organizational, semantic and technical within a political context.

In this paper we focus on the semantic interoperability and the political context in Flanders as these levels are in line with the OSLO-program as described in the introduction.

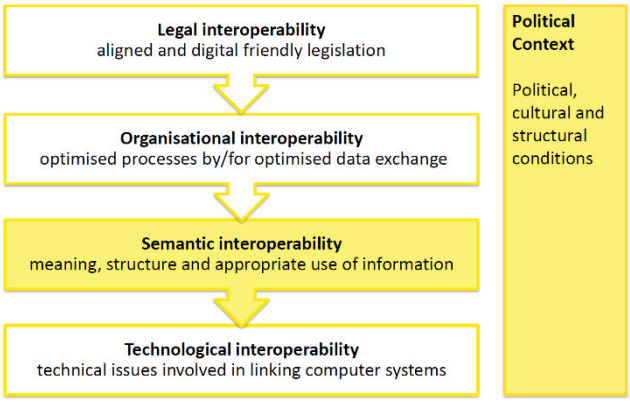

Figure 2: European Interoperability Framework[10]

2. RESEARCH GOAL AND METHOD

This paper aims to represent and validate this first OSLO program which delivers a canonical data model and a process to arrive at an agreement for facilitating better semantic interoperability. In this paper, we describe the involved stakeholders, the process, our methodology, the implementation of OSLO as three PoCs and the output and outcome of the OSLO program. We also elaborate on the conditions and contextual factors that influenced and shaped the implementation of OSLO.

This study used an inductive approach, data was gathered via action-research [11]. This approach refers to the involvement of researchers as co-practitioners in the setting under study and the attention paid to the context where the events took place [12]. Additional data was gathered via desk research.

3. UNPACKING THE SEMANTIC PROCESS

In this section we will compare the process and methodology of developing the OSLO semantic agreement with the approach defined by the ISA program. We will discuss the 'stakeholders' and the steps to reach the semantic agreements among these stakeholders (the 'specifications process'). The 'methodology' describes how the model will be developed. The model is as a starting point for the 'implementation'.

[9] http://ec.europa.eu/isa/documents/isa_annex_ii_eif_en.pdf, p. 3

[10] http://ec.europa.eu/isa/documents/isa_annex_ii_eif_en.pdf, p. 21. Figure 4-1.

Our methodology was based on ISA best practices: 'Process and methodology for developing core vocabularies'. ISA defines a "Core Vocabulary" as a simplified, reusable, and extensible data model that captures the fundamental characteristics of an entity in a context-neutral fashion [16]. These Core vocabularies cover the semantics of a small set of generic concepts which support semantic interoperability among public administrations in Europe and were a starting point for new semantic agreements in the context of administrations in Flanders. Meanwhile these vocabulaties are alse being adopted outside Europe, including the IMI Core Vocabulary in Japan [11].

The ISA program also provided guidelines for consensus building on semantic agreements among stakeholders and a methodology for developing semantic agreements [15], which is based on the "Process and methodology for developing Core Vocabularies".

3.1 Stakeholders

The ISA guidelines first identify the various stakeholders which are involved in developing and maintaining semantic agreements. They identify the 'authority'. In case of OSLO our approach was bottom-up rather than top-down. The authority[12] consisted of representatives of the membership organizations (ICT, secretary, financial managers) of local governments, regional and federal administrations.

According to ISA, "the activity is undertaken by a group of organizations that have decided to build shared services that require their information systems to operate", referred to as 'Members'. In case of OSLO the members[13] were the consortium partners who funded the project, referred to as the 'steering committee'. Among them V-ICT-OR (NPO), local governments, the regional governments, application developers, and a start-up.

The third group identified in the ISA guidelines is "the wider community" that have an interest in the agreements, in case of OSLO this group was made up by academic partners and ISA[14].

3.2 Specification Process

The 'specifications process' describes the roles of the stakeholders and the steps to reach the semantic agreements among these stakeholders.

In the OSLO-specification process, the steering committee which represents the 'authority' agreed among the stakeholders on the working groups, which were grouped per thematic agreed domain. OSLO focuses on three thematic domains: Contact Information, Localization, and Public Services. Each domain has a dedicated working group. In each domain the relevant entities, relations and attributes were discussed and iteratively refined and formalized. The steering committee validated each iteration of the domain model, specifications and the vocabulary. The steering committee agreed among the stakeholders on the working groups, which were grouped per thematic agreed domain.

The ISA specification-process describes two variants. The first is for complex activities and includes a domain working group and two or more Data Entity Subgroups. The second variant is targeted at simple projects that build upon an existing domain model, in this case the working groups are merged into one workgroup. We aligned the process of the development of each domain in the model to the second ISA specification process [15].

In case of new entities that had no vocabularies (such as describing the relationship between a natural person and a registered organization) or when multiple entities with complex relations were involved (such as public services) break-out sessions were organized to zoom in on specific objects with other participants. This process aligns with the first version of the ISA specification process [16].

To ensure that anyone can freely use and distribute the results of the project, the OSLO-specification and all related documentation[15] were published under an Open License. OSLO adopted the ISA Open Metadata v1.1 license[16]. This license also protects the 'authority' from liability claims in case the use of OSLO causes damage.

3.3 Development methodology

In this section we describe how the model was developed. The model served as the starting point for the 'implementation' phase.

The ISA methodology consists of five phases:

1. The domain working group focuses on use-cases that enable them to derive the requirements.
2. The domain working group develops a rough-cut Domain Model, based on the requirements of step one.
3. The data entity subgroups refine the domain model by adding attributes and linking to existing vocabularies.
4. The domain working group integrates the results of the data entity subgroups into the global domain model.
5. A conformance statement is created. The ISA methodology used a 'meet-in-the-middle' approach [20], focusing on stakeholders commonalities rather than on their differences.

Immediately after the kick-off of the project, OSLO working groups created an inventory of the challenges and use-cases related to the exchange of information for local public administrations in Flanders. This resulted in three main modeling domains of interest: (i) persons and organizations, (ii) locations, and (iii) public services, see Figure 3. The specification for OSLO was developed by a multidisciplinary Working Group, with a total of 58 people from 28 organizations (all of them are listed in the specification). The working groups followed the same approach, with one workgroup per topic, integrating the domain working group and the data entity subgroups.

For the conformance criteria OSLO defined a conformance statement with different levels of engagement, represented by stars, aiming to lower the threshold:

- One star requires a human-readable mapping to OSLO;
- Two stars requires the mapping needs to be machine readable;
- Three stars requires the data to be in line with the OSLO vocabulary;

[11] https://joinup.ec.europa.eu/sites/default/files/ckeditor_files/files/3-IMI%20project%20in%20Japan%20L.pdf

[12] https://www.v-ict-or.be/kenniscentrum/overleg/e-gov-competentiecentrum

[13] https://www.v-ict-or.be/assets/5384d510ce3fb57c500006ad/OSLO1.1-specificaties.pdf, p 113.

[14] https://www.v-ict-or.be/assets/5384d510ce3fb57c500006ad/OSLO1.1-specificaties.pdf, pp 96-98.

[15] https://purl.org/oslo

[16] https://joinup.ec.europa.eu/category/licence/isa-open-metadata-licence-v11

- Four stars adds requirements on the provenance of the data;
- The fifth and final star requires HTTP content negotiation[17], in which the client can specify the response format (e.g. HTML, RDF/XML, Turtle),

3.4 Implementation

The starting point for the implementation is the domain model (as mentioned in section 3.3), delivered by the process described in section 3.2.

The OSLO semantic agreement focuses on three domains*: Contact Information*, *Localization*, and *Public Services*. Each of the models are local extensions of the ISA Core Person, Business, Location, and Public Service vocabularies created at European level in the context of ISA. These four core vocabularies are simplified, reusable, context neutral and extendable specifications for information exchange.

Terms appointing the structure of data and representing real world or abstract concepts might have an ambiguous meaning or multiple interpretations. 'What do we consider as an address? Is it a residence or a domicile, or the place where someone works?'. The context determines the meaning of each term. Contact information of a person might contain other data, depending on his/her capacity (e.g. responsible in an enterprise, representative of an organization, or as natural person). Figure 3 shows the conceptual domain model capturing all the important entities.

Contact Information. OSLO introduced a new concept to describe the relationship between a natural person and a (registered) organization: 'in de hoedanigheid van ...', of which the closest English translation is 'in the capacity of ...'. It is related to and best captured by the concept of Membership in the ISA Organization vocabulary, though it is not exactly the same: a citizen is not simply a citizen, in a different organization each citizen might take up different roles or functions which are obviously linked in a very particular way to the fact that a person is 'member' of an organization. The concept of 'hoedanigheid' intends to capture this subtle nuance. ISA will start incorporating this concept this year in the Core Powers and Mandates vocabulary [10]. The concept that expresses each 'capacity' a person has, functions as a unique identifiable object, and is a specialization of the broad concept of 'Agent' (e.g. occurs in the FOAF vocabulary). It is enriched with contact information. Each capacity a person takes up might come with different ways in how to reach this person. This contextual information is captured by the OSLO model.

One of the most interesting aspect of the OSLO domain model, is the modeling of persons, organizations and roles. At first, it may seem that a person 'in capacity' is strongly connected to a person having a certain role in a Public Service. However, there is a strict distinction between those two concepts. For example when someone (Person) picks up a certain mandate in a local government, this mandate will be a specification, an instance, of one of the capacities a person is in (Membership). This describes the relationship between the person and the organization (local government). Along with this mandate there will be certain roles to be able to carry out the public service of this particular local government. A role has one or more permissions which are embedded in rules (a legal framework). Opposite to the Membership/Capacity, the Role is bound to a specific Public Service rather than an organization (local government). An example of such a service might be the delivery of passports. This distinction enables describing a Public Service and all the necessary roles involved without the need to immediately couple it to an instance of a person or an organization. Secondly when the person in capacity, mandate holder, takes up a certain role, the instance of the role will be linked to the Membership/Capacity through the *has Actor* property. A Person, Membership and registered Organization are specializations of the generic concept Agent. All three of them can be linked to a Contact, which is a VCARD description on how one can be contacted; and their physical location, the ResidenceObject.

Localization. The localization models the physical location of a person. This involves the physical Location which can be described by its Geometry and in case the Location is a ResidenceObject (a BuildingUnit) also an address (with possible extensions).

Public Service. A Public Service is modeled as a black box system requiring a certain input document Input and delivering a certain Product as an output (e.g. requesting an ID results in the delivery of a new ID). The Input and Product entities capture the metadata of these products and can wrap electronic documents (e.g. as XML). The Product and Input are also bound to a specific location (administrative region). Certain instances of Agent (thus of Person, Membership or Organization) have a role in the Public Service via the Role. Each Role has been granted some Permissions. Both the Public Service and Permission are following certain legal Rules.

Formalization. OSLO offers documentation for various target audiences and has a knowledge base with details on the specification (both human and machine readable):

- Specification targeted towards developers and policy makers: OSLO 1.1[18];
- Knowledge Base[19]
- Mapping guidelines[20]
- RDF and XML serialization of the vocabulary, managed on the Github and published in its own namespace with a fixed prefix[21].
- RDF namespace: purl.org/oslo/ns/localgov# resolves RDF version of OSLO.

[17] https://www.w3.org/TR/ld-glossary/#content-negotiation

[18] http://purl.org/oslo

[19] https://www.v-ict-or.be/kenniscentrum/projectfiches/OSLO/OSLO-2

[20] https://github.com/v-ict-or/oslo-mapping-guidelines

[21] https://github.com/v-ict-or/oslo_xml_schemas

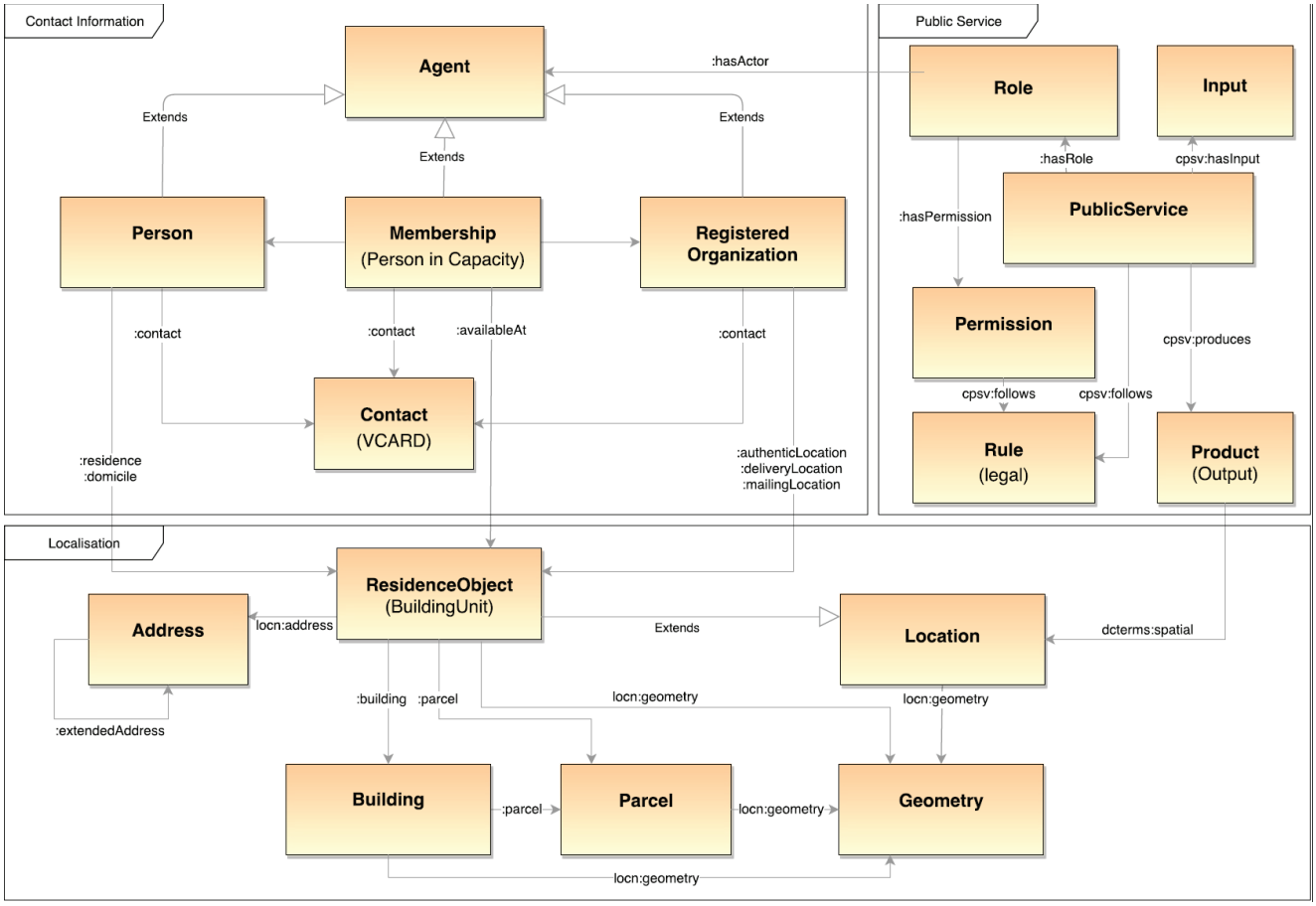

Figure 3. OSLO focuses on three domains: Contact Information, Localization and Public Services.

3.5 Outcome

The OSLO Program brought expertise together from different business domains and governmental levels, independent of a specific thematic project. This group set up an interoperable model in line with EU standards ISA and INSPIRE[22] with specific local enrichments that support the processes of the different governmental levels. The model paved the way for a policy framework with the Flemish Government[23].

OSLO is listed on several platforms for optimal dissemination:

- as an asset on the EU platform for semantic assets, Joinup[24].
- the OSLO namespace prefix is registered at prefix.cc[25].
- in Linked Open Vocabularies (LOV[26]).

Three initiatives in administration and research projects served as pilots for a preliminary implementation of the OSLO standard; the 'shared catalog for local public administrations', the crossroad database for Enterprises (VKBO) and the Local Council Decisions as Linked Data proof of concept.

- The 'shared catalog for local public administrations' pilot [4] wanted to disclose contact information related to products and services effectively between governments and towards citizens through a common interface. An extension on OSLO was developed as a convergence between various stakeholders in local government data. The extension enriched OSLO vocabulary with three new entities: Channel, Activity and Product.
- The crossroads database for Enterprises (VKBO) interlinked with a snapshot of the base address registry as Linked Open Data proof of concept[27] had its data modeled according to the OSLO vocabulary. The datasets were used for the evaluation and validation of data quality of OSLO among other vocabularies [5]. The applied methodology focusses on an approach for assessing the mappings instead of the rdf dataset itself, as mappings reflect how the dataset will be formed when generated. This methodology executes semi-automatic mapping refinements, which are based on the results of the quality assessment. In the dataset, we

[22] http://inspire.ec.europa.eu/

[23] https://docs.vlaamsparlement.be/docs/stukken/2015-2016/g522-1.pdf

[24] http://purl.org/oslo

[25] http://prefix.cc/oslo

[26] http://lov.okfn.org/dataset/lov/vocabs/oslo

[27] http://lddemo.datasciencelab.be/query/#startFragment=http://ewi.mmlab.be/ba/all

found four violations, afer manual refining the mapping definitions (according to the first mapping assessment's results), only 7% of the range violations remained. OSLO reuses ontologies but does not cause violations as the combination is harmonized following owl[28] restrictions. It only caused few errors and those are among the most frequently encountered errors with vocabularies in general, for example 'mapping a uri as a literal and vice versa'. OSLO is also used to annotate data of businesses and their locations in the COMBUST project, a platform for reliable business data[29].

- The Local Council Decisions as Linked Data proof of concept, demonstrates a method to manage Local Council Decisions as Linked Data, and aims to create a new base registry for mandates. This project from the Flemish Agency for Domestic Governance, has used the OSLO-methodology. The project extends OSLO with two new concepts: one for metadata of decisions made at a local governmental level and one for describing public mandates. By publishing decisions that are automatically in a machine-readable format, in line with international vocabularies, they are suitable for reuse by third parties (Linked Open Data) without additional efforts [2].

4. CHARACTERISTICS

Semantic interoperability is the key to create appealing citizen-centered e-government services and better reusable open government data. As explained in section 1.1. the lack of interoperable information products leads to a fragmented view of the public service concept. This is a major obstacle for creating citizen-centric services. By publishing information in line with international vocabularies, information becomes more suitable for reuse by third parties.

OSLO, and in particular its vocabulary specification, empowers a technology independent, generic representation of contact information, localization and services provided by public administrations. By its nature and design, OSLO is generic enough to be applied in a wide range of scenarios, not just for its original purpose.

However, as illustrated by the EIF (see Figure 2), it requires the necessary political support at the different governmental levels in Flanders to roll-out OSLO. Many public services delivered at the local level are dependent on data and processes from the regional government, therefore consensus at the different levels is needed.

Below we discuss the different elements (see Table 2) we have identified the influences that characterize the context of the creation of the open standard.

Ownership: the ownership of OSLO changed during the process. It started as an initiative of a mediating non-profit organization, an interest group of public servants active as IT practitioner at local government level in Flanders. At the end of the first phase (2015) the ownership was transferred to the Flemish Government.

Vocabulary alignment: the vocabulary is aligned with European initiatives: ISA and INSPIRE. Because the OSLO semantic agreement is built upon international vocabularies and the methodology guides the stakeholders towards a reusable machine readable format, we ensure that Open Government Data can be reused by third parties without the need for expensive mappings and transformations.

Adoption: Although the municipalities awareness is rising for a common agreed data standard, those who were not familiar and aware of the potential prior to the OSLO program, started to integrate some elements at their local information system management.

OSLO encountered commonly known challenges regarding its adoption [13]. There is a transition phase involved for public administrations and organizations when deciding to implement OSLO **. A**t the local government level, OSLO is being adopted in public tenders, facilitated by a whitepaper with an conformance statement [1]. The Flemish vice-minister president supported OSLO and embedded it in the strategy for the Flanders Information Agency to stepout of thinking in data silos, as mentioned in the Policy letter of Administrative Affairs Department [9].

Adaptation: albeit the 'Once Only' and 'whole-of-government'[30] principles, there remain problems to overcome the lack of integration in e-government projects. According the United Nations -Government Survey, information 'silos' are created by departmentalism and lack of coordination; "The problem lies not with the technology but in the political challenge of rewiring a range of public sector programmes delivered by different levels of government" [17]. To soften these silo's in the OSLO program, agreements on various governmental levels were also essential.

Both OSLO and ISA methodologies focus on commonalities rather than on differences. The process allows participants to focus on use-cases in an early stage, instead of defending their definitions based on their (domain specific) implementations. To ensure that published data can remain accurate, consistent across data sources and up to date, OSLO facilitates modeling public and governmental data (belonging to citizens). The uptake in the long term relies on easier access to authoritative and other data sources following the OSLO semantic agreement. This enables aligning data with authoritative sources and exchanging data among the variety of data sources. To realize this aspect of interoperability vision we need machine readable data, with standards that are supported beyond the (single) government: semantic interoperability.

Governance: as described in the Specification Process (3.2), a permanent steering committee was installed, which represents the 'authority'. The steering committee validates the installation of a new thematic working group, each new vocabulary, each review of a vocabulary and the conformance statements.

During the development period a broad coalition, mainly based on goodwill, participated in explicit use cases (e.g. the pilots, authentic base registries). This convinced other public administrators to further support such efforts and recommend it at the regional and federal level.

Although there were some early adopters within local administrations, this self-steering committee based on voluntarism lacks power to embed the standard in the legislation.

[28] https://www.w3.org/TR/owl-ref/

[29] https://www.iminds.be/en/projects/combust

[30] http://glossary.usip.org/resource/whole-government-approach

All these experiences lead to a follow-up trajectory. How OSLO could approach certain of the encountered roadblocks and the shift in critical success factors is explained in the section 'Conclusions and Future Work'.

Table 2. Characteristics of OSLO (described in this paper)

	OSLO
Ownership	An interest group of public servants active as IT practitioner at local government level in Flanders: V-ICT-OR (non-governmental body, non-profit organization).
Vocabulary alignment	Alignment with EU initiatives: ISA, INSPIRE
Adoption	Adoption in public tenders at the local government level and embedded it in the policy of the Flanders Information Agency
Adaptation	Focus on the commonalities rather than on differences, agreements on various governmental levels.
Governance	Self-steering approach with one chair / facilitator and business owners invited as experts.

5. DISCUSSION

This project introduced open standards for e-government vocabularies and guidelines for governments in Flanders. Bottom-up organized working groups delivered a reusable formal specification and serialization of domain specific models. As a result, public administrations and private partners can model people, organizations, public services and locations (including addresses and buildings) for data exchange.

Information is often not reusable in multiple contexts because information (intensive) processes are implemented in a binding legal context or a specific organizational context within a public administration. OSLO enforces the principle: 'first clarify and then digitize'. This principle is put forward in most digitalization projects but often there is a lack of political basis and support to adapt the necessary rules to cope with this principle.
Both the bottom-up and top-down approach were important to create the necessary political support. OSLO was built on consensus, rather than on a legal framework. This unique situation where different government levels are working towards consensus, can stimulate future uptakes of particular core data models by other administrations [18].

The OSLO Program increased awareness and the ISA-based-methodology led to semantic convergence creating a foundation to develop interoperable e-government services in Flanders. As tested in the "shared catalog for local public administrations" pilot, this affords providing information from different government levels through a common interface.

Because OSLO is now embedded in the strategy of the regional government, we expect this could change the characteristics as discussed in table 2.

As the ownership is transferred to the Flemish Government, a governmental organization will be the 'authority' instead of an non-profit organization. This implies a transfer of the governance and life-cycle management of the ontology to the Regional Government. In terms of Adaptation, the development of OSLO compliant products at the higher regional Government, could overcome the lack of OSLO-compliant authoritative sources.

A vigorous commitment and accountability from the regional government, could speed-up the further adaptation at local governments, regional administrations and the intergovernmental data sharing as well. The latter often implies an adaptation of the organizational processes.

Product owners that manage (authoritative) information sources at regional level could be in charge of the working groups, which can enable a governance-shift from a grass root local approach towards a central governance system co-funded by the different policy domains at the Flemish level. This could secure a more sustainable funding to support local- and horizontal regional governments in their transition towards Open Standards and Generic Building Blocks, and could help to speed-up the adoption of OSLO. The role of the Regional government could then be facilitating a harmonized information exchange policy where standardization in terms of infrastructure, semantics and data formats will play a crucial role.

6. CONCLUSION

The semantic process of OSLO showed/demonstrated that both 'Political support' and 'Semantic Agreements' are essential step stones to soften the existing information silo's and to make a shift towards an open, interoperable and citizen-centric government. To reach 'Semantic Agreements' the described process and methodology created a setting where the stakeholders focused on their commonalities rather than on their differences. In an early stage, consensus building and a meet-in-the middle approach is essential for a broad support of a semantic standard. Political support is essential to realize sustainable semantic standards through authority, engagement and sustainable sponsoring. To ensure a broad adoption at all government levels, it is important to put a more formal governmental authority in charge of the governance and align the authoritative government information sources on the agreed semantics.

7. ACKNOWLEDGEMENTS

OSLO is the result of a public-private partnership initiated by V-ICT-OR, the Flemish Organization for ICT in Local Government, and funded by Flemish ICT service providers (e.g. BCT, Belgacom, CEVI, CIPAL, Infront, Fusebux, Remmicom and Schaubroeck) and public administrations (e.g. Flemish Government AGIV and CORVE, Digipolis, Gent, Antwerpen). Invited experts with a particular expertise include public administrations (Flemish Government AGIV and Departement Bestuurszaken - AMC, Fedict and local governments), not-for-profit organizations (e.g. the 'Flemish Organization for Cities and Municipalities' - VVSG), academic partners (iMinds - Ghent University, University College Ghent) and ISA.

8. REFERENCES

[1] Audenaert, M., D'haenens, T. 2014. *Overheidsdata, standaardisatie en goed ondernemerschap*. V-ICT-OR. https://www.v-ict-or.be/assets/5450fdffce3fb537ef00014f/Overheidsdata%20en%20goed%20ondernemerschap.pdf

[2] Buyle, R., Colpaert, P., Van Compernolle, M., Mechant, P., Volders, V., Verborgh, R., Mannens, E. 2016. Local Council Decisions as Linked Data: a proof of concept. In *Proceedings*

of the 15th International Semantic Web Conference. Kobe, Japan, October 17-21, 2016.

[3] Colpaert, P., Van Compernolle, M., De Vocht, L., Dimou, A., Vander Sande, M., Verborgh, R., Mechant, P., Mannens, E.2014. Quantifying the interoperability of open government datasets. *Computer*. 10, 50–56.

[4] De Vocht, L., Van Compernolle, M., Dimou, A., Colpaert, P., Verborgh, R., Mannens, E., Mechant, P., Van de Walle, R. 2014. Converging on semantics to ensure local government data reuse. In *Proceedings of the Fifth International Conference on Semantics for Smarter Cities*. 1280. CEUR-WS. Org, 47–52.

[5] Dimou, A., Kontokostas, D., Freudenberg, M., Verborgh, R., Lehmann, J., Mannens, E., Hellmann, S., Van de Walle, R. 2015. Assessing and refining mappingsto rdf to improve dataset quality. *The Semantic Web-ISWC 2015*. Springer, 133–149.

[6] Gallo, C., Giove, M., Millard, J., Kare, R., Thaarup, V. 2014. *Study on eGovernment and the Reduction of Administrative Burden*. European Commission, p.149.

[7] Garson, G.D., Biggs, R.S. 1992. Analytic Mapping and Geographic Databases, *SAGE university paper*, volume 87, p2.

[8] Guijarro, L. 2009. Semantic interoperability in eGovernment initiatives. *Computer Standards & Interfaces*. 31,1, 174–180.

[9] Homans, L., *Beleidsbrief bestuurszaken 2015-2016*. 2015. In *Flemish Parliament* (522), p. 25. https://docs.vlaamsparlement.be/docs/stukken/2015-2016/g522-1.pdf

[10] ISA. 2014. *ISA2 Work Programme: Annex I, Detailed Action Descriptions*, p. 78.

[11] Lewin, K. (1946). Action research and minority problems. *Journal of social issues*. 2,4, 34-46.

[12] M.N.K. Saunders, P. Lewis. 2000 Research Methods For Business Students. *Harlow Financial Times*. Prentice Hall, 147-148.

[13] Nekvasil, M., Sv´atek, V. 2013. Towards savvy adoption of semantic technology: From published use cases to category-specific adopter readiness models. *Web Semantics: Science, Services and Agents on the World Wide Web*. 21, 61–74.

[14] Pardo, T.A., Nam, T., Burke, G.B. 2011. E-government interoperability: Interaction of policy, management, and technology dimensions. *Social Science Computer Review*, p. 10.

[15] Interoperability Solutions for European Public Administrations (ISA). 2013. *Process and methodology for developing semantic agreements*, p.7.

[16] PwC EU Services EESV. 2012. *Process and methodology for core vocabularies*. Tech. rep., Technical report, Interoperability solutions for European Public Administrations, p. 5.

[17] United Nations Department of Economic and Social Affairs. 2012. *United Nations E-Government Survey 2012*. United Nations, p. 69.

[18] Van Compernolle, M., De Vocht, L., Goedertier, S., Loutas, N., Verborgh, R., Mannens, E., Mechant, P., Peristeras, V., Van de Walle, R. 2016. State-of-the-Art Assessment on the Implementations of International Core Data Models for Public Administrations. In *Proceedings of the 9th International Conference on Theory and Practice of Electronic Governance. ICEGOV 2015-2016*, 327-337.

[19] Wood, D. 2011. *Linking government data*. Springer, p.112.

[20] Zeginis, D., Hasnain, A., Loutas, N., Deus, H.S. Fox, R., Tarabanis, K. 2012. Collaborative development of a common semantic model for interlinking Cancer Chemoprevention linked data sources. *The Semantic Web Journal*, p.14.